MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

SECOND YEAR FIRST SEMESTER EXAMINATION FOR BACHELOR ENVIRONMENTAL SCIENCE

ENS 240: FUNDAMENTALS OF ENERGY SCIENCE

DATE: 9/5/2019 **TIME: 2.00-4.00 PM**

INSTRUCTIONS TO CANDIDATES

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

- Universal gas constant R = 8.314 J/mol.K or 0.0821L.atm/mol.k
- Specific latent heat of fusion of ice= 335J/g or 80 Cal/g
- Specific heat capacity of water =4184 J/kgK
- Monoatomic gas $C_V = \frac{3}{2}R$ $C_P = \frac{5}{2}R$; Diatomic gas $C_V = \frac{5}{2}R$ $C_P = \frac{7}{2}R$

QUESTION ONE (30 MARKS)

a) State two major types of renewable energy plants in Kenya connected to the national grid (2 marks)

b) Briefly describe the following processes in thermodynamics

i. Isothermal (1 mark)

ii. Isobaric (1 mark)

iii. Isochoric (1 mark)

iv. Adiabatic (1 mark)

c) Show that the work done in a thermodynamic system is given by $P\Delta V$ where P is the pressure and ΔV is the change in volume (2 marks)

d) 10 moles of oxygen (O_2) are allowed to expand isothermally (T=300 K) from a volume of 10 litres to 30 litres. Calculate the work is done (3 marks)

e) (i) Define the term entropy in thermodynamics (1 mark)

(ii) Find the change in entropy when 200 g of ice at 0^oc melt into 200 g of water at 0^oc (3 marks)

f) State two ways in which a system can exchange energy with its surroundings (Use system illustrations) (2 marks)

g) i Distinguish between energy and power stating the S.I units of each (2 marks)

ii A garage hoist steadily lifts a car up 2 meters in 15 seconds. Calculate the energy and power developed to the car if its mass is 1000kg. (3 marks)

h) Define the term enthalpy in thermodynamics and state the condition for heat and change in enthalpy to be the same (2 marks)

i) The driving force for creation of wind primarily in the difference between equator and the poles has been attributed to the uneven heating of the surface. In view of this, explain the difference between air and wind (3 marks)

j) Propane (C_3H_8) reacts with elemental oxygen gas to produce carbon dioxide while giving off 2,220 kJ of energy. $C_3H_8+5O_2 \rightarrow 4H_2O+3CO_2$ = 2220 kj .Draw an energy level diagram and state with a reason whether the process is endothermic or exothermic (3 marks)

QUESTION TWO (20 MARKS)

a) State the first law of thermal dynamics (1 mark)

b) 100 J of work is done on a system whose internal energy increases by 74 J. Calculate the amount of heat transferred (3 marks)

c) i Tidal power plants attempt to harness energy of tides as they flow in and out. State two limitations of tidal power as a source of electricity (2 marks)

ii Calculate the thermal energy required to change 100 g of water from 0^oc to 100^oc (3 marks)

d) A sample of a diatomic gas of volume 4×10^{-3} m^3 at a pressure of 15 atm and a temperature of 25^oc is allowed to expand to a final volume of 1 atm. Calculate the heat, work and change in internal energy if the gas expands isothermally and reversibly (6 marks)

e) Africa produces products they do not consume and consume products they do not produce. As a result an investment and incubation centers are critical stakeholders to

advance the energy industry in developing countries. Discuss (5 marks)

QUESTION THREE (20 MARKS)

a) State the second law of thermal dynamics (1 mark)

b) Differentiate between a reversible and an irreversible processes in terms of the entropy (2 marks)

c) A spontaneous heat transfer from hot to cold system is an irreversible process. Calculate the total change in entropy if 6000j of heat transfer occurs from a hot reservoir at a temperature of 600K to a cold reservoir at a temperature of 250K assuming that there is no temperature change in either reservoir. (6 marks)

d) Show that in isobaric and isochoric processes the change in internal energy at the same temperature change is the same (6 marks)

e) 1 mole of a monoatomic gas at 27^{o}c to a final temperature of 400K at constant pressure. Calculate the amount of heat added and the enthalpy change (5 marks)

QUESTION FOUR (20 MARKS)

a) Define the term Carnot efficiency (1 mark)

b) A reversible heat engine receives 8kj of heat from a thermal reservoir at a temperature of 800K and 7kj of heat from another thermal reservoir at a temperature of 700k. If it rejects heat to a third reservoir of temperature 200K. Calculate the thermal efficiency of the engine (5 marks)

c) i Define heat engine and show that thermal efficiencies of heat engine is given by $\left(\mathbf{1}-\frac{\mathbf{Q_L}}{\mathbf{Q_H}}\right)$ (3 marks)

ii Differentiate between heat pump (HP) and refrigerator (R) and show that their difference in coefficient of performance is 1. $\mathbf{COP_{HP} - COP_R = 1}$ (5 marks)

d) i Distinguish between passive energy efficiency and active energy efficiency (2 marks)

ii Energy remains the major resource to transform a developing country. Explain why Kenya is not utilizing renewable energy sources to their fullest potential (4 marks)

QUESTION FIVE (20 MARKS)

a) Define stoichiometry in energy science? (1 mark)

b) State the law of conservation of mass (1 mark)

c) Discuss four factors that should be considered before putting a nuclear energy plant in your locality. (4 marks)

d) Propane (C_3H_8) burns in this reaction: $C_3H_8+5O_2 \rightarrow 4H_2O+3CO_2$. If 200 g of propane is burned, Determine the molar mass of propane and the mass in grams of H_2O produced.(C=12,H=1,O=16) (6 marks)

e) A 100g compound is 54.52% carbon, 9.17% hydrogen and 36.31% oxygen by weight.

i. Determine empirical formula of the compound (4 marks)

ii. Find molecular formula of an unknown compound with molecular weight of 88.1 amu using the empirical formula determine in (i) (4 marks)